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BIMONTHLY ERTS-A USER INVESTIGATION PROGRESS REPORT

September 30, 1972

Title of Investigation: Ground Pattern Analysis in the Great Plains

ERTS-A Proposal No. 60-8

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GSFC PI ID No. UN 657

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Two program objectives for the ERTS-A may be defined under this study:

1. Mapping the areal geology of selected sites in Kansas from multispectral imagery, and identification of anomalous patterns;
2. Search for large-scale ground patterns by spatial frequency analysis.

To the present time in the contract period there have been no significant problems that have impeded the progress of the investigation. Of course, part of the imagery obtained during the ERTS-A first period's coverage of Kansas was unusable for this study because of cloud cover, but this was anticipated. Even though we will have to wait for complete coverage of the state before we pick our selected test sites for intensive study, we have proceeded with preliminary analysis of the cloud free frames obtained during the first period's coverage. Initially, we also experienced some difficulty in producing image reproductions with suitable contrast and dynamic range for use on the optical processor in the spatial frequency analysis. However, we finally obtained suitable image characteristics by using Kodalith Ortho Type 3 film with development for 7 minutes at 68° F in Kodak D-19. This combination resulted in a transfer function with a gamma of 2.9, which provided enough contrast for adequate amplitude modulation of the processor pupil function.

To date all of the work in this study has been done using the images from the RBV band 2 (the only band on our standing order). We have received a total of 19 images from the first period's coverage of Kansas. Of these, 10 images were usable for geological evaluation (see attached image descriptor form). The remaining RBV and MSS bands for seven of these images were ordered on a Data Request Form dated 12 September. As soon as these other bands are received we will begin our multispectral studies. Our work since the receipt of the first usable images has consisted of preliminary manual interpretation and spatial frequency analysis on selected frames. Our selection of the sites for this preliminary study was dictated both by image cloud cover and ground geologic features. As soon as the entire state is available on cloud free images we will select our final test sites for intensive study.

Our preliminary analysis has yielded encouraging results. A short discussion and selected examples of our results to date are presented in the appendix to this report.

This early in the investigation it is impossible to discuss the significance of our results to practical applications or to estimate cost benefits. There have been no published articles or papers resulting from this investigation as yet. We have no recommendations concerning practical changes in the ERTS operational system. We have made no changes in our standing order, although the failure of the RBV system resulted in the automatic change of our standing order from RBV band 2 to the MSS band 5. We anticipate no difficulties resulting from this change. After our preliminary look at the first period's images we have no reason to expect difficulties with either conformance to the contract work schedule or adequacy of funds to complete the task. During this reporting period there has been no significant change in the contract operating personnel.

APPENDIX

During our preliminary analysis of the ERTS-A RBV band 2 images we were able to detect many geologic features and delineate several geologic formation boundaries. Also, the spatial frequency characteristics of some different geologic formations are distinguishable from each other. At the present time we do not have enough data to provide any statistical evaluation of these differences, but we hope to be able to produce more quantitative results within the next few months. And, as mentioned in the report, when we receive our retrospective order for the other spectral bands of the first period's images we will begin our multispectral analysis. Since many geologic formation boundaries are visible on the single band that we have worked with so far, we expect even greater visibility with the spectral information available in the additional bands.

A specific example of the geologic formation boundaries visible on the ERTS imagery is provided by images 1007-16563-2 and 1006-16504-2. These images cover a portion of Western Kansas centered along the Smokey Hill River. Visible on these images is the irregular boundary between Pleistocene-Tertiary gravels and Cretaceous limestone. The Cretaceous area exhibits a lighter tone on the red band images than does the Pleistocene-Tertiary unit. We noted for this area, as well as several other areas, that there is a strong influence of the different formations on the image tone as a result of different agricultural patterns. In this particular case there is also a high correlation between the geologic units and the availability of ground water, which is much more plentiful in the Pleistocene-Tertiary gravels. We would expect this to have some bearing on the agricultural practices, particularly on irrigation. This connection between the agricultural practices and geologic formations will be studied in more detail as we proceed.

Another formation boundary is visible on image 1003-16350-2, which is centered in Chautauqua County in the Southeastern part of the state. This boundary is between the Permian and Pennsylvanian systems. The visibility of this boundary is again aided by the change in vegetation or agricultural patterns. In this case there are also other factors involved. First the Permian of the Flint Hills is more resistant to weathering than the softer Pennsylvanian rocks, resulting in a higher local relief.

As a result of this higher resistance to weathering a second factor is introduced which aides visibility of the boundary. There appears on the image an indication that the Permian formation has affected the drainage pattern in the area, and portions of the Permian-Pennsylvanian boundary are delineated by streams. The ERTS-A imagery in this area, as well as the entire Great Plains Region that we studied, is excellent for the detection of major drainage networks (see the attached image descriptor form). We have not determined the consistency of visibility of lower order streams, but at first look the ERTS-A imagery appears very good for drainage basin studies in plains areas.

As a final example, the Pleistocene dune-sand area along the Arkansas River is easily identified on images 1007-16565-2 and 1006-16511-2. An enlargement of a portion of image 1006-16511-2 is shown in Figure one along with diffraction patterns of the three areas shown on the image. The diffraction patterns show the differences in spatial frequency distribution between the different areas. The middle diffraction pattern was made from the dune-sand area and shows the absence of high spatial frequency components that are present in the other two patterns taken from areas outside of the dune-sand region. Again we found that the difference in agriculture was a prime indicator of the different geologic units. The high spatial frequency components present in the top and bottom diffraction patterns are due to the visible field patterns which are absent in the dune-sand area. Also, the top diffraction pattern shows a greater number of high spatial frequency components than the bottom pattern. The reason for this is the difference in field patterns between the two areas as seen on the image. The top area contains a high density of relatively smaller fields than the bottom area, which contains several large areas that appear to be uncultivated. In the dune-sand area there are a very few fields under cultivation, but they are so sparce that they do not produce strong high spatial frequency components in the area's diffraction pattern. (It is interesting to note that the fields in the dune-sand area are circular, which indicates sprinkler irrigation systems.) As we proceed in this investigation we will study in more detail, and more quantitatively, the relationships between the spatial frequency characteristics of the ERTS images and the surface geology.

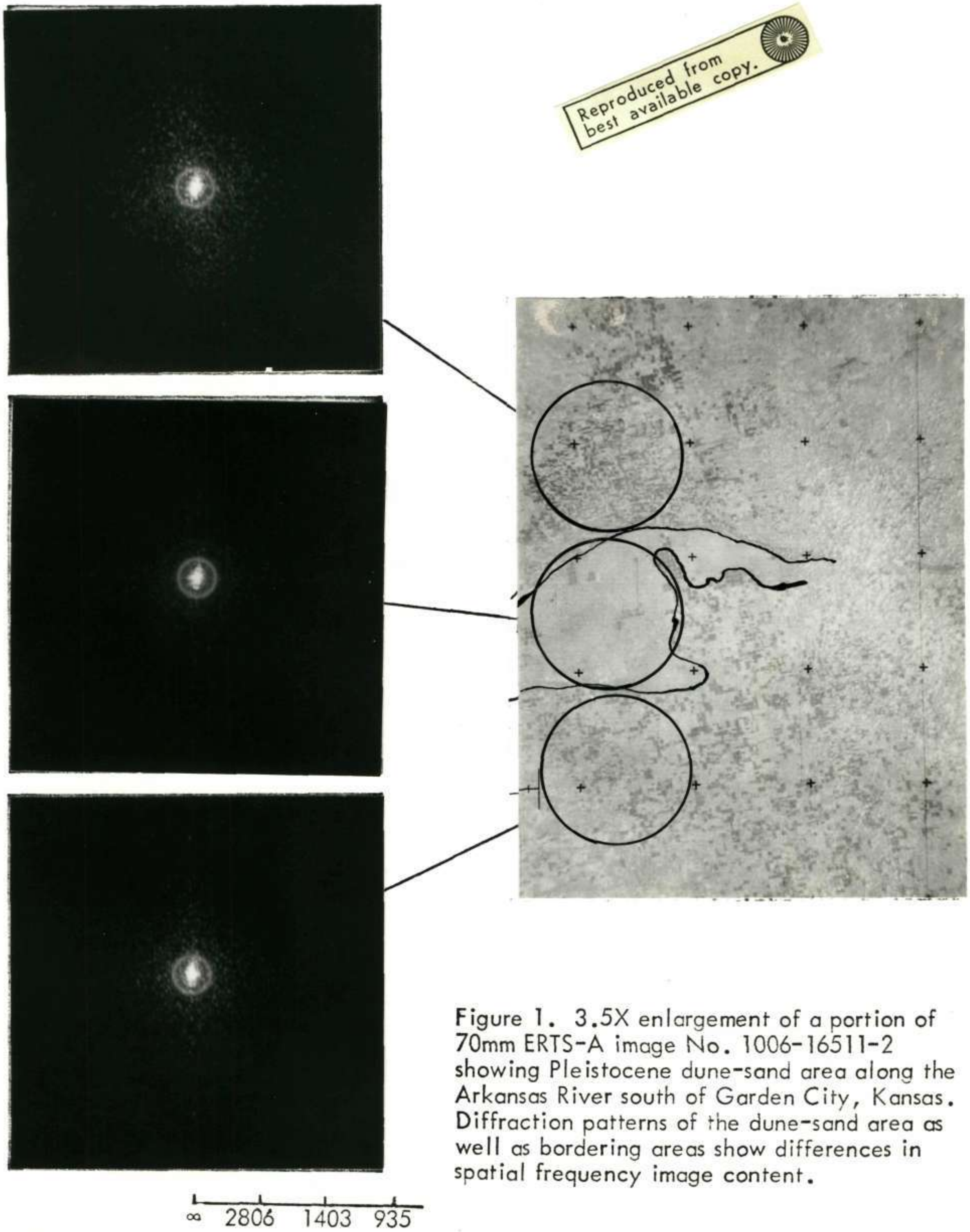

Figure 1. 3.5X enlargement of a portion of 70mm ERTS-A image No. 1006-16511-2 showing Pleistocene dune-sand area along the Arkansas River south of Garden City, Kansas. Diffraction patterns of the dune-sand area as well as bordering areas show differences in spatial frequency image content.

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
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ID

DATE September 30, 1972

PRINCIPAL INVESTIGATOR John C. Davis, Fawwaz T. Ulaby

GSFC UN 657

ORGANIZATION University of Kansas

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS* Dendritic Drainage	Stream	Floodplain	DESCRIPTORS
1003-16341-2	X	X	X	Mature Stream
1003-16350-2	X	X	X	Rangeland
1006-16502-2		X	X	Parallel Drainage
1006-16504-2	X	X		Lake
1006-16511-2	X	X	X	Dunes-Badlands
1007-16560-2	X	X	X	Parallel Drainage
1007-16563-2	X	X		Badlands
1007-16565-2		X	X	Dunes-Badlands
1008=17015-2		X	X	Dunes-Rangeland
1008-17021-2		X	X	Dunes-Rangeland
1004-16392-2				Clouds
1004-16394-2				"
1004-16385-2				"
1004-16401-2				"
1005-16442-2				"
1005-16451-2				"
1005-16454-2				"
1003-16343-2				"

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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